**PARCEL G TU 124**

Table 1 summarizes systematic sample results for Trench Unit (TU) 124, Excavated Soil Unit (ESU) Batch A (Radiological Screening Yard (RSY) Pad 4, Use 1).

| Table 1: Systematic Soil Sample Data: RSY 4 Use 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sample Identification | Sample Location | Type of Sample | Gamma Static 3x3 NaI Reading (cpm) | Gamma Static 3x3 NaI Investigation Level (cpm) | $^{226}$Ra Analytical Results (pCi/g) | $^{137}$Cs Analytical Results (pCi/g) | $^{90}$Sr Analytical Results (pCi/g) |
| Project Remediation Goals* | | | | | 1.861 | 0.141 | 0.331 |
| HPPG-ESU-TU124A-001 | 1 | Systematic | 10,360 | 14,627 | 0.449 | 0.0130 | 0.0313 |
| HPPG-ESU-TU124A-002 | 2 | Systematic | 8,407 | 14,627 | 0.509 | 0.0303 | N/A |
| HPPG-ESU-TU124A-003 | 3 | Systematic | 8,308 | 14,627 | 0.434 | -0.0353 | N/A |
| HPPG-ESU-TU124A-004 | 4 | Systematic | 8,599 | 14,627 | 0.468 | -0.0338 | N/A |
| HPPG-ESU-TU124A-005 | 5 | Systematic | 8,314 | 14,627 | 0.365 | 0.0213 | N/A |
| HPPG-ESU-TU124A-006 | 6 | Systematic | 8,510 | 14,627 | 0.551 | 0.0272 | N/A |
| HPPG-ESU-TU124A-007 | 7 | Systematic | 8,537 | 14,627 | 0.357 | -0.0405 | N/A |
| HPPG-ESU-TU124A-008 | 8 | Systematic | 8,232 | 14,627 | 0.394 | 0.0234 | N/A |
| HPPG-ESU-TU124A-009 | 9 | Systematic | 8,120 | 14,627 | 0.391 | 0.0224 | N/A |
| HPPG-ESU-TU124A-010 | 10 | Systematic | 8,109 | 14,627 | 0.517 | 0.0273 | N/A |
| HPPG-ESU-TU124A-011 | 11 | Systematic | 8,635 | 14,627 | 0.418 | -0.0201 | -0.129 |
| HPPG-ESU-TU124A-012 | 12 | Systematic | 8,407 | 14,627 | 0.471 | -0.0285 | N/A |
| HPPG-ESU-TU124A-013 | 13 | Systematic | 8,952 | 14,627 | 0.387 | -0.0329 | N/A |
| HPPG-ESU-TU124A-014 | 14 | Systematic | 8,902 | 14,627 | 0.477 | 0.0399 | N/A |
| HPPG-ESU-TU124A-015 | 15 | Systematic | 8,824 | 14,627 | 0.390 | -0.0552 | N/A |
| HPPG-ESU-TU124A-016 | 16 | Systematic | 8,627 | 14,627 | 0.392 | -0.0429 | N/A |
| HPPG-ESU-TU124A-017 | 17 | Systematic | 8,534 | 14,627 | 0.501 | -0.0198 | N/A |
| HPPG-ESU-TU124A-018 | 18 | Systematic | 8,565 | 14,627 | 0.362 | 0.00422 | N/A |
| HPPG-ESU-TU124A-019 | 19 | Systematic | 8,757 | 14,627 | 0.603 | 0.00969 | N/A |
| HPPG-ESU-TU124A-020 | 20 | Systematic | 8,866 | 14,627 | 0.466 | 0.0322 | N/A |
| HPPG-ESU-TU124A-021 | 21 | Systematic | 8,804 | 14,627 | 0.450 | -0.0427 | **0.451** |
| HPPG-ESU-TU124A-022 | 22 | Systematic | 8,702 | 14,627 | 0.465 | -0.0145 | N/A |
| HPPG-ESU-TU124A-023 | 23 | Systematic | 8,302 | 14,627 | 0.362 | 0.0272 | N/A |
| HPPG-ESU-TU124A-024 | 24 | Systematic | 9,105 | 14,627 | 0.664 | 0.000 | N/A |
| HPPG-ESU-TU124A-025 | 25 | Systematic | 8,856 | 14,627 | 0.298 | -0.0275 | N/A |
| **Soil Systematic Sample Statistics** | | | | | $^{226}$Ra Analytical Results (pCi/g) | $^{137}$Cs Analytical Results (pCi/g) | $^{90}$Sr Analytical Results (pCi/g) |
| Maximum | | | | | 0.664 | 0.0399 | 0.451 |
| Mean | | | | | 0.4456 | -0.0046 | 0.1178 |
| Median | | | | | 0.449 | 0.000 | 0.0313 |
| Minimum | | | | | 0.298 | -0.0552 | -0.129 |
| Standard Deviation | | | | | 0.0829 | 0.0299 | N/A |

Notes:

* Project remediation goal (RG) is the ROD RG (Navy, 2019) or Offsite Reference Background Area values, whichever is higher

$^{137}$Cs cesium-137

$^{226}$Ra radium-226

$^{90}$Sr strontium-90

cpm counts per minute

NaI sodium iodide

N/A not applicable

pCi/g picocuries per gram

7/1/2021

**PARCEL G TU 124**

In accordance with the *Final Parcel G Removal Site Evaluation Work Plan, Former Hunters Point Naval Shipyard, San Francisco, California* (WP; CH2M Hill, Inc., 2019), 10 percent of systematic samples are analyzed for strontium-90 ($^{90}$Sr). The radionuclides of concern (ROCs) for Parcel G sanitary sewer/storm drain lines are radium-226 ($^{226}$Ra), cesium-137 ($^{137}$Cs), and $^{90}$Sr. $^{137}$Cs and $^{90}$Sr are fission products and are often observed together. As stated in WP Section 5.4, $^{137}$Cs is considered to be the indicator for fission product radionuclides with U.S. Department of the Navy (Navy) Radiological Defense Laboratory (NRDL) activities. Analyzing systematic samples for $^{90}$Sr at a frequency of 10 percent serves to supplement the investigation and is a standard protocol for Hunters Point Naval Shipyard (HPNS), and is consistent with the $^{90}$Sr analysis frequency followed by Tetra Tech EC, Inc.

The *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (MARSSIM; U.S. Environmental Protection Agency et al., 2000) Section 4.3.2 provides justification for the use of surrogates, such as the use of a measured $^{137}$Cs concentration as a surrogate for $^{90}$Sr. If an established ratio between radionuclides does not exist, MARSSIM recommends that at least 10 percent of the final status survey measurements (both direct measurements and samples) include analyses for ROCs. The Navy has historically used this approach for sanitary sewer and storm drain removal sites as well as other areas where both $^{137}$Cs and $^{90}$Sr are ROCs. Per the WP (CH2M Hill, Inc., 2019), a $^{137}$Cs detection above the remediation goal (RG) prompts analysis of the same sample for $^{90}$Sr.

Twenty-five systematic samples were collected from the ESU, and three samples were analyzed for $^{90}$Sr. Systematic Sample 021 (HPPG-ESU-TU124A-021) has a $^{90}$Sr result of 0.451 picocuries per gram (pCi/g), which is greater than the $^{90}$Sr RG of 0.331 pCi/g. $^{226}$Ra and $^{137}$Cs results for this sample are below the respective RGs: the $^{226}$Ra result is 0.450 pCi/g and the $^{137}$Cs result is -0.0427 U pCi/g (not detected at or above the decision level concentration [DLC]). Because the $^{90}$Sr sample result is above the RG, in accordance with WP Section 3.7 and Sampling and Analysis (SAP) Worksheet #11 Step 7 (CH2M Hill, Inc., 2019), the sample was analyzed for plutonium-239 ($^{239}$Pu) by alpha spectroscopy. The $^{239/240}$Pu result for HPPG-ESU-TU-124A-021 is -0.00759 U pCi/g (not detected at or above the DLC). The other two systematic samples analyzed for $^{90}$Sr did not exceed the RG: Sample -001 is 0.0313 U pCi/g (not detected at or above the DLC), and Sample -011 is -0.129 U pCi/g (not detected at or above the DLC).

The *Multi-Agency Radiological Laboratory Analytical Protocols* (MARLAP; U.S. Environmental Protection Agency et al., 2004) states: "in most cases a sample that arrives at the laboratory cannot be analyzed in its entirety. Usually only a small subsample is taken for analysis, and the analyte concentration of the subsample is assumed to be approximately equal to that of the sample itself. Obviously a subsample cannot be perfectly representative of a heterogeneous sample." The soil at HPNS is known to be highly heterogenous. A sample can be homogenized per the laboratory standard operating procedures and still be heterogenous, as demonstrated from the results included in Table 2.

The reported $^{90}$Sr measurement is the result of the analysis of a 1-gram aliquot from the HPPG-ESU-TU124A-021 soil sample. Four additional 1-gram aliquots from the same soil sample were analyzed for $^{90}$Sr and total beta strontium to provide representative data from the sample. Table 2 presents the results from the original aliquot and the additional four aliquots.

The laboratory is not able to reanalyze the original aliquot for confirmation. Sample preparation for $^{90}$Sr analysis includes several precipitation and chemistry cleanup steps. Following a 7-day yttrium-90 ($^{90}$Y) ($^{90}$Sr daughter product) ingrowth period to approach secular equilibrium with $^{90}$Sr, the $^{90}$Y is precipitated from the aliquot and plated on the planchet. Once plated, there is limited time to count the $^{90}$Y due to its short half-life (approximately 64 hours). Therefore, the four additional aliquots were required to

provide additional $^{90}Sr$ data from the original homogenized soil sample. Laboratory quality assurance (QA)/quality control (QC) methods and samples were reviewed and there are no QA/QC issues with these samples.

Table 2: HPPG-ESU-TU124A-021 $^{90}Sr$ Results

| Sample Identification | $^{90}Sr$ Analytical Results (pCi/g) | Total Beta Strontium Analytical Results (pCi/g) |
|---|---|---|
| Project Remediation Goal | 0.331 | N/A |
| HPPG-ESU-TU124A-021 | 0.451 | NA |
| HPPG-ESU-TU124A-021 (Additional Aliquot 1) | 0.0225 U | -0.0720 U |
| HPPG-ESU-TU124A-021 (Additional Aliquot 2) | -0.0108 U | 0.0347 U |
| HPPG-ESU-TU124A-021 (Additional Aliquot 3) | 0.0508 U | 0.0167 U |
| HPPG-ESU-TU124A-021 (Additional Aliquot 4) | -0.228 U | 0.0215 U |
| **Sample Statistics:** | | |
| Maximum | 0.451 | 0.0347 |
| Mean | 0.0571 | 0.000225 |
| Median | 0.0225 | 0.0191 |
| Minimum | -0.228 | -0.072 |
| Standard Deviation | 0.246 | 0.0487 |

Notes:

$^{90}Sr$ strontium-90
NA not analyzed
N/A not applicable
pCi/g picocuries per gram
U not detected at or below the decision level concentration

The four additional aliquots are below the RG and were not detected at or above the DLC. Table 2 includes sample statistics. The mean concentration for $^{90}Sr$ is 0.0571 pCi/g and the mean concentration for total beta strontium is 0.000225 pCi/g. While the original sample result exceeds the $^{90}Sr$ RG, it could not be reproduced by the laboratory. It is evident from the additional aliquot results that true $^{90}Sr$ concentration within the sample is below the RG and that elevated activity is isolated to a small amount of soil within the sample.

Additionally, $^{137}Cs$ is considered to be the indicator for fission product radionuclides associated with NRDL activities (CH2M Hill, Inc., 2019), and $^{137}Cs$ results from the 25 systematic samples are below the $^{137}Cs$ RG, which is often observed with $^{90}Sr$. Because $^{90}Sr$ was not detected at concentrations above the RG in the four additional aliquots, and there is no evidence of elevated $^{137}Cs$ concentrations, the observed measurement of 0.451 pCi/g is believed to be due to heterogeneity of fallout within the sample and not the result of Navy-related soil contamination.

In accordance with WP Section 5.5 (CH2M Hill, Inc., 2019), a comparison to background was made. WP Section 5.5 states comparison of site data with background may include, but is not limited to, population-to-population comparisons, use of an MLE (maximum likelihood estimate) or BTV (background threshold value), graphical comparisons, and comparisons with regional background levels. WP Section 5.5 states if residual ROC concentrations are consistent with NORM (naturally occurring radioactive material) or anthropogenic background, site conditions comply with the Parcel G Record of Decision (ROD; Navy, 2019) Remedial Action Objective (RAO).

To evaluate potential background concentrations of natural fallout, the *Final Background Soil Study Report, Base Realignment and Closure Program Management Office West, Former Hunters Point Naval*

*Shipyard, San Francisco, California* (CH2M Hill, Inc., 2020) Section 7.2 outlines data evaluation steps. Section 7.2.1.1 states "If [ROC] concentrations at a site are greater than the background values, further consideration with respect to literature values may be warranted." As summarized in Table 7-2 of the report, $^{90}$Sr concentrations in background (i.e., atmospheric fallout) data reported in literature range from 0.069 to 0.75 pCi/g (CH2M Hill, Inc., 2020). The initial sample result of 0.451 pCi/g is within this reported range of anthropogenic background.

Based on the lines of evidence described above, the 0.451 pCi/g $^{90}$Sr result does not represent an exceedance of the ROD RAO and is not considered Navy-related contamination. As a conservative measure and in accordance with WP Section 5.3.2 (CH2M Hill, Inc., 2019), Aptim Federal Services, LLC (APTIM) will remove all the material on the pad surrounding Systematic Sample 021. Dimensions of the removal will be approximately 2 feet by 2 feet by 9 inches (depth of lift) and will include and surround Systematic Sample 021 for an approximate removal volume of 3 cubic feet. This material will be disposed as low-level radioactive waste. APTIM will collect four bounding samples from the remediated RSY pad area to confirm the horizontal extent. Because the full 9 inches of soil within the 2-foot by 2-foot remediation area will be removed, there will be no remaining soil at the bottom of the lift to sample to confirm the vertical extent. The bounding samples will be analyzed for $^{90}$Sr. In accordance with the WP and SAP Worksheet#11 Step 7, samples will also be analyzed by gamma spectroscopy for $^{137}$Cs and $^{226}$Ra. Following receipt of remediation samples confirming removal of soil exceeding the RGs, an RSY pad data package will be prepared and submitted for Navy review and approval. The RSY pad data package will summarize remedial actions and systematic, biased, and remediation sample results.

References:

CH2M Hill, Inc., 2019, *Final Parcel G Removal Site Evaluation Work Plan, Former Hunters Point Naval Shipyard, San Francisco, California*, June.

CH2M Hill, Inc., 2020, *Final Background Soil Study Report, Base Realignment and Closure Program Management Office West, Former Hunters Point Naval Shipyard, San Francisco, California*, June.

U.S. Department of the Navy, 2009, *Record of Decision for Parcel G, Hunters Point Shipyard, San Francisco, California,* February.

U.S. Environmental Protection Agency, U.S. Nuclear Regulatory Commission, and U.S. Department of Energy, 2000, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),* NUREG-1575, EPA 402-R-97-016, DOE/EH-0624, Revision 1, Washington, D.C.

U.S. Environmental Protection Agency, U.S. Nuclear Regulatory Commission, and U.S. Department of Energy, 2004, *Multi-Agency Radiological Laboratory Analytical Protocols,* NUREG-1576, EPA 402-B-04-001A, NTIS PB2004-105421, July.